METHOD FOR ENERGY COUPLING ESPECIALLY USEFUL FOR DISINFECTING, AND VARIOUS SYSTEMS USING IT

FIELD OF THE INVENTION

The present invention relates to the field of acoustic energy coupling. It is further relates to the field of light radiation coupling. More specifically it relates to coupling said energies via liquid medium.

BACKGROUND OF THE INVENTION

Acoustic energy is used in the various fields of medicine (e.g. ultrasound imaging devices, kidney stone disintegration devices), industry (e.g. plastic soldering, paint peeling), lifestyle and health (e.g. swimming pool algae prevention, air humidifying) and furthermore.

A first aim of the present invention is to expand the range of industrial applications where a sonic energy may be effectively utilized, to fields that currently do not utilize this type of energy. This will be accomplished hereinafter either by disclosing a pioneering innovative medium for sonic energy administration, further, by disclosing an extraordinary synergism effect between the acoustic energy thus administrated and between other energy types that are also may be administrated via same medium, and furthermore, by disclosing another extraordinary synergism effected between the acoustic energy and between the medium substance itself.

Many ultrasonic applications need a medium (other than the free atmosphere) for coupling between the sonic energy generator and between the space or surface where the energy should act.

Reference is herewith made to WO patent no. 02/38447 (titled Disinfection Through Packaging), wherein according to several embodiments of this patent an acoustic energy should cause the air capsule trapped between a container cap and the apex of a liquid there contained, to be extended downwardly for being mixed with the

liquid, in order to create inside the container an inherent homogenous light diffuser made of the plurality of refractive index profiles between the liquid and the plurality of air bubbles mixed therein. Said light diffuser is for the homogeneous distribution of a UV 355nm light pulse, for disinfecting the container and its content. Extending the air capsule downwardly and converting it to a plurality of air bubbles mixed with the liquid could be performed either by creating a vortex by energizing the molecules of the liquid to a rotational momentum about a vertical axis of the container, or by shocking the liquid molecules by a momentum directed from the bottom of the container upwardly.

Hence, another aim of the present invention is to provide a new method and means for transferring acoustic energy pulses from a sonic generator inside a capped liquid container.

One known method for peeling and removing old or damaged paint from outer surface of boats, ships, and submarines, as a preparation for a new paint, is by the use of ultrasonic wave, concentrating it to a location on paint to be removed, while rinsing the removed paint by a water stream directed to the treated location. This is another example of coupling between an ultrasonic energy source and a surface to be treated, wherein the coupling is made through air, resulting in a vast lose of sonic energy to the surrounding. The present invention is aimed to resolve such energy lose problems as well.

The use of ultrasonic energy in the fields of disinfecting, cleaning, decontaminating and purifying, is well known. Ultrasonic waves are utilized to prevent the creation of algae in water reservoirs or pools, and to disconnect and remove microorganisms from walls and surfaces of liquid reservoirs and pools. However, many bacteria and microorganisms types withstand even high energy sonic waves to which they are exposed, due to their flexible specific body construction. Therefor, numerous trials were made for decades, and methods were developed, in order to combine the known good attributes of UV light in the field of disinfecting and destroying noxious species, with the ability of ultrasonic waves to treat and damage other noxious species. Unfortunately, strict limitation hindering geometrical utilization have prevented engineers, scientists, and manufacturers, from further developing multidisciplinary technology platform involving UV and ultrasonic energies simultaneously.

Hence, another and main aim of the present invention is to provide a very efficient platform where both UV light and Ultrasonic energies, could be very effectively utilized.

A further aim of the present invention is to provide a way by which noxious species could be disconnected from surfaces for being washed up or destroyed while located at the volume laying open to damaging energies.

Another aim of this invention would therefor be to provide a way by which large volumes of liquid could be disinfected by reduced amounts of energy.

SUMMARY OF THE INVENTION

The present invention relates to acoustic energy coupling, using liquid as an energy transfer medium.

One reason why the present invention was titled "energy coupling" (opposing to e.g. 'energy conduction') is to emphasize that there is a utilization of the energy for doing 'work', namely there is an intention to consume the delivered energy at the delivery destination, rather than using it as an information carrier.

Therefore, rather than using a medium for transferring informative data through electromagnetic or sonic waves, in the context of the present invention the term "energy coupling" relates to the use of a medium for transferring energy from a source to a destination, wherein said energy is being administrated in at least such dose rates sufficient for altering mechanical or chemical properties at the destination.

Altering mechanical properties according to the present invention refers to changing either a construction, a shape, or a relative placement of bodies.

Altering chemical properties refers to breaking or creating atomic or molecular bonds.

Static liquid is a well known medium for transferring acoustic energy. However, the pioneering concept of the present invention is the use of a streaming liquid as a medium for acoustic energy, and especially the use of a non-piped liquid jet as a medium for transferring acoustic energy from a source (sonic waves generator) to act at a destination site with energy doses sufficient to alter mechanical or chemical properties at the destination site . The present invention further relates to light radiation coupling, using liquid as a medium. Liquid is a well known medium for transferring light radiation energy. However, the pioneering concept of the present invention is the use of streaming liquid as a medium for coupling light radiation energy, and especially the use of a non-piped liquid jet as a medium for coupling light radiation energy.

The present invention further relates to the synergistic aspects of coupling energies generated by more than one energy sources, e.g. coupling both acoustic and light radiation energies via streaming liquid medium (and via non-piped liquid jets in

particular), or e.g. for coupling (or synchronizing) between more than one source generating the same sort of energy (namely sonic or electromagnetic) and may be but not necessarily differing from each other in their particular properties such as their wavelength, PRT (i.e. Pulse Repetition Rate), or power level.

This is a second reason why titling the present invention "energy coupling", that is to say that two or more energy types may be coupled inside the streaming liquid medium according to the present invention in order to gain powerful synergistic processes as will be further explained in detail.

Furthermore, the present invention relates to a conversion of light radiation into sonic waves and to a conversion of sonic waves into light radiation, inside the streaming liquid. In addition, the present invention relates to the utilization of said light-to-sonic (hereinafter referred to also as LTS) conversion and of said sonic-to-light (hereinafter referred to also as STL) conversion, as a means for controlling and administrating the processes for which said light or sound are intended.

It should be appreciated that non-piped liquid can be used as a light guide due to the relatively high refractive index of liquids comparing to the refractive index of the surrounding air. In other words, it is due to the relatively low velocity of light in liquid comparing to its velocity in the air. The opposite is true with sonic energy. The sound velocity in liquid is higher than in air, which in a first glance, using the same logic of what happens with light, could have been lead to a conclusion that sonic energy will be lost to the surrounding air if it would be guided via non-piped stream of liquid.

The reason why sonic wave remains locked within non-piped liquid jet is that differently than light energy that only passes through the medium (with the energy accumulated in its futons), sonic energy in liquid is a kinetic energy of the liquid molecules themselves (that move and vibrate in waves). Due to the extremely high density of liquid comparing to the density of air, there will be a negligible loss of kinetic energy from a non-piped liquid jet to the surrounding air. Therefore, in spite of the negatively directed refractive index between liquid and air, a sonic wave guided through non-piped liquid stream would reach a remote destination with a negligible energy lose.

According to this concept, both light and sonic energies could be transferred via streaming liquid, also via non-piped liquid jets. This could be done on both directions, i.e. with or against the liquid stream.

The method for coupling energy in order to change mechanical or chemical property of target molecules or microorganisms according to this present invention, comprises;

(a) providing energy having predetermined parameters in terms, power, wavelength, duty cycle and repetition rate, projected from an outlet of at least one energy source;

(b) providing a stream of liquid having a predetermined flow rate;

(c) directing said stream of liquid to a contact with a destination site;

(d) directing said energy along a trajectory of said stream of liquid;

maintaining said stream on said destination site for a period and under conditions sufficient for altering at least one chemical or mechanical property of at least 50 percent of particular target molecules or of particular microorganism species located between the energy source and the destination site.

In various of its embodiments the present invention suggest a relative motion between the liquid stream and the target site. For example, a plurality of destination sites such as containers to be disinfected or to be aseptically filed, may be periodically replaced opposite the stream of the liquid, i.e. by their movement along a conveyor, while the liquid stream is being maintained in contact with each destination site (i.e. container) for said period and under said conditions.

In other embodiments of the present invention, the stream of the liquid may be moved along a plurality of destination sites while being maintained in contact with each destination site for said period and under said conditions. For example, a disinfecting system using the method of the present invention may be loaded upon a vehicle, wherein said vehicle can move along a line of objects (e.g. mammals) suspected as afflicted by noxious biological species or by toxic chemicals, while

maintaining the stream of the liquid for a period and under conditions sufficient for disinfecting said objects.

The destination site according to the present invention may be pre-filed containers, filed containers, surfaces, humans, mammals, vehicles, medical instrumentation, conveyors, conveyor belts, foods, fruits, vegetables, salads.

The energy to be coupled may be a sonic vibration energy, preferably in the range of between 15 KHz and 1 GHz, or a light energy radiation preferably having a wavelength of between 1nm and 1,000nm, or a combination thereof.

According to one preferred embodiment of the present invention, at least one energy source is a laser.

Most preferably (and especially for disinfecting processes), said laser is a pulsed 266nm laser. However, for disinfecting through packaging, said laser is a most preferably a pulsed 355nm laser.

According to the present invention the liquid stream is non-piped along at least one portion of its path. In most cases the non-piped portion is that between a water outlet from which projects the stream of the liquid towards the destination.

According to one preferred embodiment the liquid stream is piped inside a quartz pipe along at least one portion of its path. The quarts pipe should be surrounded by air in order to prevent light escaping from the liquid-quartz core to an absorptive surrounding substance. Most preferably is to use the quartz pipe all along the path along which light energy should pass from the energy source towards the destination.

In preferred embodiments using the method of the present invention either for rinsing, cleaning, peeling or disinfecting processes, the energy is preferably comprises sonic vibration waves in a frequency and amplitude useful for removing particles or microorganisms from a destination surface to which they are being attached.

For disinfecting destinations suspected as afflicted by noxious bacteria spores, the sonic vibration waves should be in a frequency and amplitude useful for cracking

spores. When the energy comprises sonic vibration waves in a frequency and amplitude useful for cracking or disintegrating microorganisms (e.g. spore state bacteria) between the energy source and the destination site, a powerful synergistic effect between light and sound could be achieved by further coupling via the stream of liquid an UV light radiation.

The synergism is because after the spores have been treated by the sonic energy, even small energy doses of UV radiation being significantly useful for neutralizing such damaged microorganisms located between the energy source and the destination site. This synergism effect which allows for an extreme reduction in the UV-energy required for treating spores, enables to implement disinfecting processes that were unavailable until now, due to the ineffectiveness of UV light alone (i.e. without sound) to comply with such processes in a cost-effective manner.

There is another significant synergism effect between light and sound so used. The ultrasonic waves administrated to the destination via the stream of liquid, are useful also for vibrating the microorganisms attached to the destination surfaces and for disconnecting them from the surfaces to which they are attached. This disconnection reduces the amount of contaminants at the destination, firstly since it allows for simply rinsing the microorganisms by the stream of liquid, and secondly since it meaningfully increases the chance UV futons to reach and damage at such microorganisms which previously were more hidden and protected between micro wrinkles of surface to which they were attached.

The energy sorts and properties are predetermined in adaptation to the process type and extent (e.g. production rate). According to the various embodiments of the present invention the acoustic and/or the electromagnetic energies may be pulsed in pulses having amplitude of between 1 watt/cm^2 and 1Gwatt/cm^2, time duration of between 1atosec and 1 sec, and frequency of between 1Hz and 1Ghz. A CW (continuous waves) form or a combination between pulsed energy and CW energy may be applicable as well, according to various embodiments. In such embodiments the pulsed waves may be of light energy and the continuous waves of sonic energy or vise versa, or a combination thereof, all according to the specific process to be carried out.

According to another preferred embodiment of the present invention the energy is in a form combining pulsed waves from at least two energy sources. These separate energy sources may differ from each other in their wavelength, PRT, or power level. They may also be synchronized to emit their energy pulses in correlation. For example, and according to the most preferred embodiment, a first energy source is a pulsed 266nm laser, another energy source is a pulsed 355nm laser, the pulses of which follows within 150nsec the pulses of said first energy source. According to this embodiment, those futons of 266nm pulsed laser that cause electron excitation in the DNA of noxious microorganisms, insufficiently however to breaking a bond, are shortly being followed by 355nm futons that finish the mission, by supplementing the relatively small energy dose required for removing an electron from an excitation level out of the bond. Since 355nm UV futon is significantly 'cheaper' than that of 266 nm, the use of that preferred embodiment may reduce the cost of mass production disinfecting line.

According to numerous embodiments of the present invention the method further comprises monitoring at least a part of the waves of energy on at least one location between the energy source and the destination site. Data so monitored may be used for controlling the amplitude, frequency, repetition rate or duration of the energy output of the at least one energy source, in order to adapt these properties to the executed process, or in order to learn the attributes of a process in order to further improve it. According to the preferred embodiment light created by sound (i.e. during a cavitation created by high energy sonic pulse) is monitored for controlling the characteristics of the sound, and sound created by light pulses is monitored for controlling the characteristics of the light (namely when the monitored waves are of light, the controlled energy source is of sonic energy, and when the monitored waves are of sound the controlled energy source is of light). This innovative feedback method allows for noise-free monitoring and administrating of the energy sources involved, due to the fact that peripheral flashing caused by the original pulse does not affect a local sensor monitoring its conversion into the other sort of energy.

The present invention relates to embodiments wherein the energy is coupled for disinfecting (i.e. disinfection through packaging, aseptic filing, disinfecting conveyors), for cleaning and purifying (i.e., for rinsing toilets), disintegrating

sediments (i.e. paint peeling), or for triggering chemical reactions (i.e. advanced oxidation procedures).

Most preferably, the liquid to be used as a medium for coupling the energy for the majority of disinfecting procedures, is water. The use of water for disinfecting processes according to the method of the present invention allows for cheaper and safer disinfecting procedures, without involving toxins and with no need of complicated chemical processes such as currently being used in most industrial disinfecting procedures.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a method for coupling wave-type energy via streaming liquid flowing along a trajectory from a source to a destination site. Said trajectory is via surroundings having refractive index for the specific energy lower than that of the liquid, or having density at least 3 times smaller than that of the liquid. This is in order to guarantee transmission of energy with negligible losses to the surroundings.

Suppose the energy is acoustic, the liquid is water, and the surroundings is air, most of the acoustic energy shall be preserved as a kinetic energy of the water molecules while only small part energy will be transferred to air molecules, due to the small density of the air relatively to that of a water.

In case the energy is light, the liquid is water and the surrounding is air, the energy shall remain locked in the liquid due to the greater refractive index of the water. However, it should be appreciated within the scope of the present invention to use a substantially transparent intermediate material layer between the liquid and the surroundings, although this intermediate layer has a refractive index greater than that of the liquid. For example, a water streaming within a quartz pipe surrounded by air shall not lose to the air the light energy guided within. This is because the quartz to air refractive ratio will lock most portion of escaping light waves, back into water, or to further being transmitted via quartz until reaching the destination site.

The method according to the present invention comprises the following steps:

(a) determining flow rate for the streaming liquid sufficient for a predetermined functioning of said liquid at the destination site, wherein the functioning may include (but not limited to) any conventional use of such liquid; consumption of the liquid itself (e.g. by filling it into containers); use of the liquid for rinsing surfaces, containers, conveyor belts, vehicles; use of the liquid for cutting; use of the liquid or any kinetic energy accumulated in its molecules to disconnect or peel sediments, microorganisms, or material layers from surfaces.

(b) adapting to said flow rate the wave length or frequency, power, duty cycle, and repetition rate properties of at least one energy type to be coupled

through said streaming liquid. For example in case the liquid flow rate was doubled due to multiplying by twice the velocity of a production line (suppose for aseptic filing of containers) being the destination site, the total energy being used, shall be increased in order to guarantee disinfecting of the increased liquid amount per time unit. In most cases this may be done by increasing the repetition rate of the pulses of energy being used, or by increasing its power level, or a combination thereof. In some applications increasing the duty cycle (namely the pulse width) may be considered as well (an example wherein increasing the total energy per time unit may not be accomplished by increasing the pulse width is when a shortened pulse width is essential for damaging microorganisms, without damaging a package material being penetrated by such a pulse or without causing molecule migration). The adaptation according to this step is such that said properties are in a useful ratio with the flow rate for changing at least one predetermined mechanical or chemical characteristic or for triggering such a change, in at least 50 percent of a plurality of particles or microorganisms species predetermined as being subject to said characteristic changing, and located or suspected to be located between said source and said destination site. The value of 50 percent was selected for general uses of the method that do not concern about partiality of a carried out treatment, however for security or health related application the percentage may increase up to 100%, according to consumer demand. For example, when disinfecting from noxious species (such as anthrax bacteria) 100% neutralization of species is a demand, thus the energy properties should be adapted to the water flow rate accordingly ;

The information leading to a successful choice of the liquid flow rate, and to a successful adaptation of appropriate energy type and properties to such flow rate may be gathered either prior to performance through advancing experiments, or in real time, using a computerized self learning feedback system with sensors reporting the concentration of specific materials or species at a given moment, the energy concentrations at given moments and in different locations along the streaming trajectory, and alike. The information may be gathered and kept in tablets in various computerized formats for further calculations in order to optimize energy properties to different application using different liquids and various flow rates. The third step of the method of the present invention is the practical implementation, that is -

(c) directing energy projected from an outlet of at least one energy source into and substantially along the streaming trajectory of a streaming liquid, said energy having the properties predetermined according to step c, said streaming liquid having the flow rate predetermined according to step b, such that said energy changes the at least one mechanical or chemical characteristic of at least 50 percent of said plurality of particles or microorganisms.

As already mentioned, acoustic energy is one of the wave type energies concerned by the present invention. According to various preferred embodiments of the present invention the acoustic energy is in the ultrasound range, namely in a frequency greater than 20KH.

Ultrasonic waves in the frequency range of 20KHZ and 100MHZ are especially useful in cracking or effectively damaging spores. The construction of spores is highly resistible against UV-light, even at relatively high energies. On other hand, vegetative state bacteria species is highly resistible against ultrasound waves. The combination of UV-light together with ultrasonic waves extremely reduces the dose of UV-energy required to penetrate and destroy the thiamin portion of a spore, due to the fact that the ultrasonic waves are cracking the spores or at least seriously damaging them, thus allowing a relatively low energy UV radiation to reach the spore thiamin. Since thiamin absorbs at 265nm, the use of 266 nm UV laser in combination with appropriate ultrasound wave, result in a powerful synergistic effect, allowing for absolute destroy of both vegetative and spore states of all dangerous bacteria species, using relatively small energy amounts.

However, because ultrasonic energy at its actual past and today's generating abilities may be used (at reasonable basic costs and at economical maintenance expenses) only for treating small liquid volumes, there was no massive industrial demand nor mass production use of said phenomenal synergistic effect, up to date. The pioneering concept according to the present invention according which these two energy types are integrated into one system, while relatively small volume of liquid is treated per time unit, and while said volume is being laid along a directional path, opens new horizons in the field of disinfecting in particular, and in the field of beverage and food industry in general. Since the streaming liquid is laid along a directional path, and since all particles or microorganisms subject to the treatment moves on along said path in a substantially known advancing velocity resulting from

the predetermined liquid flow rate, their exposure time to the energies is a direct function of the path length. Hence, having a given energies, and having a production line demanding a pre specified liquid flow rate, the path length for obtaining a guaranteed disinfecting (or other required process) may be easily calculated.

According to one preferred embodiment the present invention relates to a method for disinfecting through packaging, wherein ultrasonic energy is coupled through a stream of water to a bottom of a capped container intended to be disinfected. Said ultrasonic energy causes the contained liquid raging until mixing up the air capsule trapped between the cap of the container and the apex of the contained liquid. The air bubbles thus mixed in the liquid, form a homogeneous light diffuser inside the container. A 355 nm UV laser light is being directed (preferably through the same stream of liquid utilized for coupling the ultrasonic) into the container, disinfecting the entire container and content.

According to another preferred embodiment the present invention relates to a method for advanced oxidation of noxious chemical or biological sources, wherein OH- ions are created inside a water stream as a result of water molecule dissociation caused by the energy pulses administrated along the water trajectory, or by mixing with the water H2O2 or other oxidizing agent, such that noxious microorganisms or dangerous substances located between the liquid source and the destination are being oxidized by sade oxidizing agents. The process may further include the step of spraying the destination with a fog of a water solution containing oxidizing agent such as TiO2 or H2O2 , and triggering an advanced oxidation process by means of directing into the fog a water stream with an UV light thereby coupled.

The method according to the present invention further relates to disinfecting and cleaning industrial conveyors and conveyor belts. According to the preferred embodiment, at least one water jet projector with UV and ultrasonic waves thereby guided, is positioned underneath and towards the surface of an endless conveyor, wherein the conveyor is being washed up and disinfected during its conveying operation by means of the water stream and by means of the energy thereby guided.

The method of the present invention further relates to purifying and disinfecting liquid or food containers prior their filing, and also relates to an aseptic filing of liquids into containers.

The method of the present invention relates also to rinsing and disinfecting leaf vegetables, salads of sliced vegetables, or the like, using plain water without toxins, as a basis for the rinsing...

Additionally to the various embodiments of the method of the present invention, the present invention relates to various embodiments of a system using said method, comprising: (a) liquid supply; (b) at least one liquid launching nozzle in liquid communication with said liquid supply and capable of directing a liquid stream towards a destination site; (c) at least one energy generator capable of directing energy into and along a trajectory of the liquid towards the destination; (d) conveyor or robot, capable of periodically positioning a plurality of destination sites opposite the at least one nozzle, such that each destination site is being maintained opposite the liquid stream for a period sufficient to alter at least one chemical or mechanical property of at least 50 percent of particular target molecules or of particular microorganism species located between the energy source and the destination site;

The present invention will be further described by Figures 1 - 4. Those figures are solely intend to disclose some preferred embodiments of the system according to the present invention, and in no manner intend to limit its scope.

Brief description of the figures:

Figure 1 illustrates a preferred embodiment of a basic disinfecting system according to the present invention.

Figure 2 illustrates a basic Y shaped concentrator for coupling energy from two energy sources to one destination.

Figure 3 illustrates a preferred embodiment of a basic conveyor belt disinfecting system.

Figure 4 illustrates a system for Disinfecting Through Packaging according to the present invention.

Detailed description of the figures:

Figure 1 illustrates a system (1) according to the present invention, comprising a liquid supply (2) that is a 10 Liter reservoir, connected to a liquid launching nozzle (3), through a quartz core pipe (4). The quartz pipe has an opening (5) through which a probe (6) of an ultrasound transducer (7) is inserted for being immersed inside the liquid flowing from the liquid supply (2) towards the nozzle (3). The quartz pipe further has opening (8) for receiving a laser beam (9) emitted from a laser unit (10). Due to a Venturi pressure appropriately obtained by the liquid flow, there is no water leakage through opening (8), thus the laser beam can be directed into the water stream without any intermediate optics. The water (11) thus projected from the nozzle (3) with the two sorts of energy thereby locked, hit the destination (12), purify and disinfect it. The water then gathered, drained, and recycled into the water supply (2) by means of funnel (13), pump (14) and return pipe (15). The length of the pipe (4) is meant to allow for sufficient exposure period of the water to the ultrasonic waves and to the UV laser radiation, that is useful for disinfecting the water before hitting the destination. The pipe can be designed in a rolled up shape, in order to gain the length needed for the disinfecting, without occupying exaggerated room.

Thanks to its water recycling feature, said embodiment enables to disinfect a large number of containers using a very small volume of water. The water should be replaced (or filtered) only in case their turbidity exceeds a predetermined threshold indicating that a reduction in the UV radiation effectiveness may occur.

Figure 2 illustrates a Y shaped concentrator (21) using for either coupling two sort energies, or for coupling two energies of one sort differing from each other in their particular characteristics such as wave length, PRT, amplitude, or duty cycle. In the present figure, it is being used for coupling and correlating between 266nm laser pulses emitted from a first laser unit (22), and between 355nm laser pulses emitted

from a second laser unit (23) following the pulses of the first laser, with a delay of 100nsec.

In order to avoid loss of energy in light coupling, it is most preferably to have the Y shaped concentrator made of materials having refractive index lesser than that of the liquid. An equivalent arrangement is the use of a Y shaped quartz pipe surrounded by air. Each of the two energy types is directed through opposite wing of the Y shape, wherein the liquid flows through both wings then unified with the two energies therein, towards the destination. The destination (in this particular context) may be the final one (i.e. the location at which the energy intended to be consumed) or a mid one, let say another wing of a Y concentrator or splitter, at which the liquid with the energies thereby locked, should be unified with another energy type, or should be splitting to another two destinations. A clarification is herewith made that the Y shape is only an example relating to a minimal concentrator (and also splitter in its opposite direction) having three wings (ends), however, a plurality winged concentrators (splitters) may be used according to the present invention in a similar manner, and may be combined in a modularly growing shape, thus creating a net of concentrators and/or splitters, according to application requirements. An example of one-to-five splitter is shown (39) in Figure 3.

Figure 3 illustrates a conveyor belt disinfecting system (31) according to the present invention, comprised of a water supply (32), connected through pipe (38) and branch-out quartz piping (39) to a series of five launching nozzles (34) located across and beneath an endless conveyor belt (35). Ultrasound transducer (33) and laser (34), are directing ultrasound waves and UV radiation, both having appropriate predetermined properties, into the water streaming from the water supply (32) towards the series of nozzles (34). The conveyor belt is thus periodically being rinsed and disinfected, while the ultrasound energy enhance the rinsing by vibrating and removing sediments and noxious species from the belt (35), and further enhance the disinfecting process by cracking spore state bacteria, thus preparing them to their final destruction by means of the UV laser radiation. A great saving in water consume is achieved by the water recycling system, consisting of the funnel (13), pump (14) and return pipe (15) which drain and return the water back into the water supply (32), for further being disinfected by the ultrasound and laser energies during its flow along

the main quartz pipe (38) and branch-out quartz piping (39) to its continuous endless conveyor belt disinfecting process.

Figure 4 illustrates a system (41) for disinfecting through packaging. A capped PET container (42) filed with mineral water (43) is seen, positioned on a conveyor (42), the conveyor consists of two parallel endless belts with a gap in between, wherein the container leans on both belts and over the gap.

A water jet (44) is seen, launched from a launching nozzle (45), guiding thereby high intensity light pulses emitted from a 355nm laser (46), together with ultrasound energy, also guided through the same water jet, from sonic generator (47).

The ultrasound thus coupled to the bottom of the container causes the water inside the container raging and mixing-up the air capsule trapped underneath the container cap with the mineral water, creating a plurality refractive index light diffuser inside the bottle. This homogeneous light diffuser scatters the 355 nm UV homogeneously all over the container and its content. One second later, the completely disinfected container is shifted forwardly on the belt, allowing for same procedure to be carried out on another container, and once again.